

ical irritation is very enlightening in this respect, as he was able to induce similar changes, though of a much milder grade, by rubbing areas of normal skin day after day; and states that in certain pathological conditions the effects of irritation are much more pronounced.

My thanks are due to Dr. Trimble for the privilege of recording one of the cases, and for photographs of both of them, and to Dr. M. L. L. Welzmler, for assistance in preparing the histological material.

## A STUDY OF GASTRIC SEDIMENTS AND THEIR INTERPRETATION.

BY B. B. VINCENT LYON, A.B., M.D.,

CHIEF OF CLINIC, GASTRO-INTESTINAL DEPARTMENT, JEFFERSON HOSPITAL;  
PATHOLOGIST TO METHODIST HOSPITAL; ASSISTANT PATHOLOGIST TO  
GERMAN HOSPITAL, PHILADELPHIA.

SEVERAL years ago in aspirating the contents of a stomach by means of an Ewald aspirating bulb I noticed on the withdrawal of the tube that a small piece of tissue had been caught in the eye of the tube. This little fragment (although not more than 2 mm. in size), appropriately hardened and stained, gave a beautiful picture of the glandularis and muscularis mucosae, at which level rupture had taken place. The case was one of gastritis acida, and I was impressed particularly with the desquamation and exfoliation of the cells at the periphery, to which attention has previously been called.<sup>1</sup> Thinking that such desquamation and other degenerative changes might occur more frequently than was generally believed, I determined to make the recovery of gastric sediments a routine procedure.

The first method employed was to save all of the wash water from the lavage of the fasting stomach and allow it to sediment by gravity in 1000 c.c. conical graduates, and after a few hours to decant the supernatant fluid down to the last 100 c.c., and on centrifuging this, lift up the sediment by a platinum loop, and after making an ordinary slide smear, to stain it, differentially, with eosin and methylene blue. Crude though this method was, one was often repaid by recovering recognizable elements, such as leukocytes, moulds, fungi, various bacterial groups, and, surprisingly, often epithelial cells or even bits of mucosa, from a study of which it seemed possible to make certain definite diagnostic inferences. There were marked disadvantages, however, in having to deal with large amounts of lavage water, often 3000 or 4000 c.c., which

<sup>1</sup> Cf. Anthony Bassler, *Med. Rec.*, November 30, 1907.

required several hours to settle before being centrifuged, during which time many regressive degenerative alterations might occur in standing at room temperature. Furthermore, the making of even several platinum loop smears, from the centrifuge sediment, only represented a fractional amount of the total sediment. So after various modifications were applied the following method was adopted and carried out, first in the gastro-intestinal department of the German Hospital and later in the stomach clinic at Jefferson Hospital.

To make the procedure less formidable to the patient, instead of using the ordinary size stomach tube the use of a small metal capsule was suggested by my colleague, Dr. J. Quincy Thomas. This capsule is 1.5 cm. long by 6 mm. in diameter, and having a shaft 4 mm. long by 3 mm. in diameter, to which a small capillary rubber tube is securely fastened by a silk thread. The capsule is perforated at the extreme tip with a hole 1.5 mm. in diameter, in a line continuous with the caliber of the tube, and the body of the capsule is similarly perforated with eight additional holes 1.5 mm. in diameter. To facilitate cleaning the capsule is made in two parts, which unite by a screw thread. These metal tips are similar to those introduced by Einhorn for the recovery of duodenal contents or for duodenal feeding, but are made of German silver and silver plated, which is inexpensive and serviceable. The capillary rubber tube attached to this capsule is 1 meter long and of various calibrations. The smallest one that can be serviceably used is 3 mm. in diameter. This tube can be readily swallowed with minimal discomfort, and can be left *in situ* for several hours to admit of fractional analysis of the gastric juice after an Ewald breakfast, or allowed to pass into the duodenum for the recovery and analysis of duodenal or jejunal contents.

A good routine practice is to have the patient swallow the capsule and tube on an empty stomach, preferably in the early morning fasting state, and by means of a one- or two-ounce aspirating syringe, with a capillary tip and supplied with a close-fitting asbestos plunger, gentle aspiration is made to recover the residual contents of the fasting stomach, after which from 100 to 150 c.c. of plain, warm water is introduced by means of the syringe and gently aspirated and forced back again into the stomach, perhaps a dozen times. After the first several re-aspirations it can be usually observed that the lavage water, which was at first macroscopically clear, becomes gradually turbid and contains variously-sized flocculent bodies, ranging from pin-point to 3 to 5 mm. in size. During this period of aspiration and re-injection a stethoscope should be applied to the abdominal wall in the gastric area, and the size, shape, and position of the stomach can be readily mapped out by determining the maximum lines of intensity of the auscultatory tinkling and bubbling sounds. After thus douching the

gastric mucosa, all of the fluid is aspirated from the stomach and then a small portion tested for occult blood and the remainder mixed with equal parts of a 10 per cent. solution of formalin. The residual gastric contents or material aspirated from the stomach is recorded in cubic centimeters, allowed to filter, and the filtrate tested for its acidity to determine hypersecretory states; the filter paper is then punctured and the residue washed into a clean bottle with the 10 per cent. formalin solution, and both specimens, properly labeled, are then sent to the laboratory to be handled in the following way:

TECHNIC OF PREPARING SEDIMENTS FOR STAINING. 1. Add to gastric washings an equal quantity of 10 per cent. formalin and allow to stand for at least three hours.

2. Filter through a smooth filter paper. After filtration wash the sediment down to the tip of the filter paper by means of a wash bottle.

3. Cut off the tip of the filter paper containing the sediment. Fold the paper to prevent the escape of the sediment. Wrap the paper in one layer of gauze; tie it fast with a thread.

4. Place in acetone I for one hour.

5. Place in acetone II for one hour.

6. Place in acetone III for two hours.

7. Place in paraffin and chloroform, each one hour.

8. Place in paraffin (M. P., 52° C.), each one hour.

9. Place in paraffin (M. P., 52° C.), each two hours.

10. Imbed in paraffin.

(a) Attach to a block of vulcanized fiber by means of melted paraffin a piece of cardboard, 6 x 12 x 2 mm.

(b) Unfold the filter paper and remove the sediment. Mold it into a small block and attach to the paste-board with melted paraffin.

(c) Wrap around the block a piece of paper 25 mm. wide, previously dipped in paraffin.

(d) Float block in iced water and fill the paper box with melted paraffin (M. P., 52° C.)

(e) Trim the paraffin down to the plane of sediment.

11. Cut serial sections.

12. Float the sections on warm water and place them on slides previously covered with a thin layer of Meyer's egg albumen.

13. Wipe off the excess of water from the edges of the slides.

14. Place the sections in a dry heat sterilizer, at 70° to 80° C., for thirty minutes or until sections are perfectly dry.

*Staining.* 15. Place sections in xylol (in Coplin's jars) for five to ten minutes to remove paraffin.

16. Place sections in absolute alcohol for five minutes.

17. Place sections in 95 per cent. alcohol for five minutes.

18. Place sections in 80 per cent. alcohol for five minutes.

19. Place sections in water for five minutes.
20. Place sections in hematoxylin for five minutes.
21. Place sections under a slow stream of running water until they turn blue.
22. Place sections in a weak aqueous solution (about 1 per cent.) of eosin.
23. Place sections in 80 per cent. alcohol for a few seconds.
24. Place sections in 95 per cent. alcohol for a few seconds.
25. Place sections in absolute alcohol for a few seconds.
26. Place sections in xylol for ten or more minutes (to clear).
27. Mount in balsam.

*Normally*, in the slides from the aspirated fasting residue one finds occasional epithelial cells; occasional leukocytes with protoplasm intact in those cases in which chemical titration shows faintly acid or neutral or slightly alkaline reaction. Boas and Paul Cohnheim have pointed out that digested protoplasm of epithelium or leukocytes indicates the presence of free hydrochloric acid and pepsin. When the protoplasm of the epithelial cells is still intact it is possible to differentiate endogenous gastric cells and those originating from the mouth, pharynx, respiratory track, and esophagus. Normally, one frequently encounters the snail-like bodies, first described by Jaworski,<sup>2</sup> which Boas and Paul Cohnheim believe to be mucus, which have been acted upon by hydrochloric acid. If there has been regurgitation from the duodenum there may be crystals of some of the bile salts.

*Pathologically*, in the fasting morning stomach one may find remnants of food eaten the night before, such as muscle fibers still striated or partially digested; starch granules; vegetable cells; seeds from berries, any of which from the twelve-hour fasting stomach is indicative of motor insufficiency, due either to pyloric obstruction or rarely to advanced atony. Associated with this, if one finds sarcinæ in numbers or many yeast cells in process of germination it would suggest gastric dilatation with stagnation and fermentation. Sarcinæ are rarely found in the ectasia of cancer, except the ulcer carcinomatosum type. It should be remembered that small amounts of food remnants are not significantly pathological (cryptic mucosæ and cavities in teeth).

Paul Cohnheim attaches importance to infusoria like *Trichomonas hominis* and *Megastoma entericum*, and believes they are associated with cancer when the motility of the stomach is not affected. Personally, I have never encountered them. They require for their development an absence of hydrochloric acid, an alkaline medium, and a cryptic mucosa. Mucus from the respiratory track will float, owing to its air content. Microscopically, it is characterized by containing alveolar cells and myelin drops, while colum-

<sup>2</sup> Münch. med. Wehnschr., 1887.

nar epithelium indicates its derivation from the gastric mucous membrane. Also, in gastric dilatation one occasionally encounters spores and mycelial cells from vegetable moulds. Leukocytes are indicative of an inflammatory reaction. It has been stated that if they occur in large numbers it is strongly suggestive of phlegmonous or suppurative gastritis, an extremely rare condition. It has been my experience, however, to find large numbers of leukocytes in all cases of gastric ulcer, in many of the simple forms of gastritis in the inflammatory or congestive stage, and in cancer of the stomach, affecting chiefly the glandularis. Pathologically, a significant finding is the presence of Oppler-Boas bacilli, which most usually occurs in the subacid or anacid gastric juices, associated with retention and stagnation. Most commonly the presence of lactic acid is readily demonstrable when these bacilli are found. Their presence has so often been seen to be associated with cancer of the stomach as to be extremely suggestive of this condition, but by no means pathognomonic. They are large non-motile bacilli with a somewhat typical morphological arrangement in long chains, and are readily differentiated from the *Leptothrix buccalis* by acting negatively to Gram's stain. In gastric sediments prepared as above described they have a tendency to arrange themselves in dense masses, interlaced with one another, and resemble hair-like balls when viewed under a low-power microscope.

The normal stomach should contain very few bacteria, and when they do occur in large numbers it has been considered to be due to a gastric juice poor in antiseptic property. I believe when the bacterial flora of the stomach is found high that one is dealing with a distinctly pathological condition. The most common normal invader of the stomach is the *Bacillus coli* group, but the appearance of diphtheroid bacilli, staphylococci, and particularly various types of streptococci indicates trouble. Here, too, one meets with a pathologically increased number of leukocytes.

It is surprising how often small isolated fragments or flakes of gastric mucosa will be recovered by this method. Minute particles, barely of macroscopic size, which would readily escape detection in the lavage water, may prove to be the one point upon which the correct diagnosis can be made. Furthermore, it is often possible, from a microscopic study of these bits of mucosa, to determine from which segment of the stomach they come, whether the fundic, prepyloric, or antrum pyloric, bearing in mind the anatomical distribution of the different types of glands. Microscopically, these minute fragments may show only the peripheral portion of the villus, extending down to various depths through the glandularis, while in the larger fragments the entire width of the mucosa, at times including the muscularis mucosæ, will be found. It is often possible to differentiate accurately the following conditions:

**CANCER OF THE STOMACH.** It is not uncommon to find (see Cases III and IV, Figs. 4 and 8) fragments of gastric mucosa which show gastric tubules with broken basement membranes and atypical invasive proliferation of the epithelial cells through the interglandular stroma, and other glands may show various types of degeneration, parenchymatous, mucoidal, vacuolary, or atrophic. In all these retrogressive degenerations the staining reactions are poor as compared with the progressive carcinomatous changes. If the fragment of mucosa extends down to the submucosa, finger-like processes of carcinomatous invasion affecting the fundic portions of glands, or even collections or nests of carcinoma cells involving the lymphoid tissue, often showing beautiful mitotic figures, may be found. There is almost invariably a well-marked leukocytic infiltration of the interglandular stroma, frequently associated with pyogenic bacteria, particularly streptococci. When bits of mucosa with recognizable glandular elements can not be found, one may frequently see microscopic fields showing areas of necrosis, plentifully studded with polynuclear leukocytes and invaded by bacteria. Often in the centre of these eosin-stained areas of necrosis may be seen masses of granular amorphous-like debris, staining heavily with methylene blue or hematoxylin, which suggests the remains of degenerated epithelial cells, carcinomatous or other, in all stages short of coagulation necrosis (see Figs. 2, 3 and 5). One finds the bacteria massed chiefly at this point, the degenerated cells evidently furnishing an excellent pabulum. Around these necrotic areas will frequently be found immense numbers of Oppler-Boas bacilli, often arranged in such dense clusters of interlaced bacteria as to resemble balls of hair when viewed under low power (see Figs. 2, 3 and 5).

Occasionally one will find fairly large clusters or nests of recognizable cancer cells, often in number up to 100 cells, as in Case I of this series (see Fig. 1). In cancer cases with pyloric obstruction the twelve-hour fasting stomach sediment will show various food rests, meat fibers, vegetable cells, starch granules, fat droplets, or crystals, and if there is fermentation, yeast cells in abundance. Red-blood corpuscles may occasionally be found intact, more commonly in various stages of crenation, and most frequently as hematin crystals. Crystals of bile salts may also be found.

Even if definitely diagnostic isolated cancer cells or bits of mucosa showing carcinomatous degeneration can not be found, the presence of areas of necrosis showing leukocytic infiltration and bacterial invasion will strongly suggest either gastric cancer or gastric ulcer. If Oppler-Boas bacilli are present and the chemical analysis of the gastric juice approaches the subacid or anacid curves the diagnosis points more particularly to cancer (see Chart I, Case IV). A positive Wolff-Junghans reaction would support this point of view.

It is, of course, understood that, as a rule, these laboratory

findings are the tail to the kite as compared to a carefully taken anamnesis, physical examination, and a critical clinical scrutiny of the case; but coupled with the latter they may prove to be the turning-point in the diagnosis, and, indeed, it not unfrequently occurs that the diagnosis is definitely pathologically made by the finding of recognizable cancer cells (see Cases I, III, and IV, Figs. 1, 4, and 8).

**GASTRIC ULCER.** While it is more difficult here to make a definitely pathological diagnosis from a gastric sediment study, nevertheless the finding of areas of necrosis with numerous leukocytes and pyogenic bacteria indicates the presence of an ulcerative process whether superficial or deep. The absence of Oppler-Boas bacilli is likewise suggestive. If coupled with this there are bits of the glandularis mucosæ showing the gastric tubules well marked and the cells reacting sharply to the differential stains and the interglandular stroma invaded by leukocytes, the likelihood of this diagnosis would be increased (see Fig. 10). Here, too, one frequently encounters isolated exfoliated epithelial cells, particularly the border or cover cells, reacting well to eosin, either intact or showing granular degeneration. A normal or hyperchlorhydric fractionation curve of the gastric juice, especially when associated with the presence of occult blood, would support this contention. It should be thoroughly borne in mind, however, that the presence of occult blood by no means always indicates ulcer or cancer, it being so frequently encountered in superficial erosions, in states of chronic passive congestion with a friable gastric mucosæ, and in many cases of achylia gastrica, as recently pointed out by J. T. Pilcher<sup>3</sup> in a series of cases studied at the Mayo Clinic.

**CHRONIC GASTRITIS.** In hypertrophic glandular gastritis and gastritis acida the pathological diagnosis depends upon the finding of fragments or flakes of mucous membrane presenting a well-marked hyperplasia of the glandular elements, with the cells showing good staining power. This applies most particularly to the base or fundic portion of the glands, whereas the cells toward the periphery will often show granular degeneration, loss of staining power, and absence of nuclei. This peripheral portion frequently desquamates or sloughs off and is found in isolated areas of the microscopic field (see Fig. 7). The interglandular stroma is seen to be infiltrated with an increased number of leukocytes of the lymphoid type in the more chronic processes and a predominance of polynuclear varieties in the acute stages. The venules are usually enlarged or dilated, and areas of pigmentation and congestion may be seen.

**ATROPHIC GASTRITIS.** Here recoverable bits of gastric mucosa will show a considerable diminution in number of the gastric tubules, with marked irregularity in their distribution; their alignment is

<sup>3</sup> Jour. Amer. Med. Assoc., November 19, 1910.

very imperfect and few glands can be traced from fundus to neck. The cells stain poorly and show mucoid and fatty degeneration, with marked vacuolization. Frequently, cells are seen separating or completely broken off from the basement membrane and lying in the lumen of the tubule. In fact, all of the epithelium may be completely denuded from the tubule, leaving empty spaces in the mucosa.

The leukocytic infiltration is usually of the lymphocytic type, and areas of venous congestion are relatively infrequent. In the same microscopic field, or in other portions of the sediment in the same case, may be found bits of mucosa showing practically normal glandular elements, and it may be rightfully argued that the findings of such microscopic fragments of the mucosa showing various pathological states may not represent a true picture of the amount of organic damage or degree of functional power of the stomach as a whole. Nevertheless, the above findings, associated with the study of the fractionation curves, will often corroborate or point out the clinical diagnosis.

**ACHYLIA GASTRICA.** In the recovery of bits of mucous membrane in cases of this type the noteworthy features have been the pronounced reduction in the number of glandular tubules in various stages of benign degeneration (Fig. 9, Case V). These degenerations consist chiefly of the mucoid type, which is probably a later stage of a simple parenchymatous degeneration. Later cystic dilatations appear, and in some cases there occurs rupture of basement membranes with atypical epithelial proliferation, showing a tendency to invade the surrounding stroma. Such cases should be most carefully investigated, and repeated attempts to recover additional mucosal fragments should be made, as it may prove to be a transitional stage between a benign and an early malignant achylia. Particularly in these cases does the Wolff-Junghans reaction offer a possible means of differentiation. In all this group of cases there is a marked increase in connective tissue in the interglandular stroma, and at times wide bands of it may be seen separating small islands of degenerated tubules. Indeed, it is possible that this connective tissue overgrowth in the benign achylia may be a forerunner of that rare condition *Linitis plastica*. The depth of the glandularis is strikingly diminished, and it is not uncommon to find that a single low-power microscopic field takes in the entire depth and width of the glandularis, including the muscularis mucosæ, at which point rupture most commonly occurs. At the peripheral portion of the glandularis may be seen dilated venules markedly congested and with extravasation or diapedesis of red-blood corpuscles, which explains the occasional (frequent?) demonstration of occult blood.<sup>4</sup> At the peripheral portion, too, may be

<sup>4</sup> Cf. Pilcher, Jour. Am. Med. Assn., November 19, 1910.



found a deep layer of mucus, and islands of mucus may also be seen in isolated portions of the sections.

When one is successful in recovering fragments of mucosa showing these pathological changes it checks up nicely the fractionation curves of the achylic type and would serve to differentiate between the psychical achylia occurring during the first stage of digestion and the total chemical achylia persisting throughout the entire digestive cycle (see Chart II, Case V).

**GASTRIC ATONY WITH DILATATION.** In the early cases the sediment returns are usually negative save for amorphous debris and patches of mucus in which are enmeshed occasional leukocytes. In the more advanced cases with benign motor insufficiency are found various food rests even on a twelve-hour fasting stomach, although it is uncommon to find this unassociated with some degree of pyloric stenosis.

**GASTRIC DILATATION WITH FERMENTATION.** In cases of gastric dilatation with fermentation one will frequently find in addition groups of sarcinæ, germinating yeast cells, spore-bearing fungi, and mycelial threads. Bacteriologically, many groups of organisms may be represented, chiefly, however, of the spore-bearing type.

**HYPERSECRETION CONTINUA (REICHMANN'S DISEASE).** Often-times the sediments are practically negative except for a granular amorphous debris with crystalline deposits of bile salts. If there is an associated inflammatory condition (a gastritis), one will find the nuclei of numerous leukocytes with protoplasm digested as well as free nuclei from exfoliated epithelial cells. In the inflammatory types under oil immersion can frequently be made out a marked increase in the bacterial flora. Since so many cases of hypersecretion are found associated with gastric dilatation sequential to either atony, pylorospasm, pyloric stenosis, or chronic appendicitis, food rests may be frequently encountered.

**ESOPHAGEAL SEDIMENTS.** Similarly, in douching the esophagus by this method one may recover esophageal sediments of diagnostic import, as in cases of cardiospasm with esophageal dilatation. In cases of esophageal cancer, minute bits of tissue containing nests of cancer cells may be found, together with necrotic debris, studded with leukocytes and invaded by bacteria. In cases of esophagitis following the ingestion of corrosive poisons there may be recovered bits of necrotic mucosa showing a high degree of ulcerative inflammation. It is noteworthy that in cardiospasm, and I believe this to be pathognomonic of this condition, it will be found possible to douche the esophagus and recover from the esophagus all of the lavage fluid introduced without having to pass the tube into the stomach. (This point has been repeatedly demonstrated in a case which will be reported in full at an early date.)

**CONCLUSIONS.** 1. The routine study of gastric sediments will be found to give information of both diagnostic and prognostic importance.

2. In those cases in which are recovered fragments of mucosa showing pathological alterations the clinical diagnosis may be checked up or supported as in no other way short of surgical exploration. This is notably the case in cancer of the stomach involving the glandularis. One may be rewarded by positive findings in comparatively early cases of cancer, which are clinically of the borderline type.

3. In clinically doubtful or obscure cases exhibiting gastric symptoms a study of one or several slides of gastric sediment may reveal sufficient pathological evidence to point correctly the diagnostic accusing finger.

4. A single pathologically negative sediment means nothing, and is to be regarded in the same way as failure to recover tubercle bacillus from the sputum of patients clinically tubercular.

5. Repeated pathologically negative sediments in a given case argues strongly in favor of functional rather than organic gastric disease.

6. When organic disease is strongly suspected, notwithstanding repeated pathologically negative sediments, one should critically survey the technic of obtaining and preparing the specimen.

I desire to acknowledge the courtesy of Dr. John B. Deaver, in the use of hospital notes on some of his patients on whom these studies were made, and to express my thanks to Dr. Carl E. Becker, of the pathological laboratory of the German Hospital, and to Mr. John Eiman, of the pathological laboratory of the Methodist Hospital, for their cordial coöperation and their painstaking care in the preparation of the specimens.

#### REPORT OF CASES.

CASE I (Carcinoma of the Stomach).—H. F., aged sixty-two years; married; occupation, machinist.

*Chief Complaint.* Indigestion, with vomiting and constant pain in the stomach.

*Present Illness.* Four months ago he began to get pain in his stomach, occurring two to three hours after meals and relieved by eating. This relief would last for two hours and then the pain would begin again. About the same time he began to get attacks of vomiting; says he never vomited blood, but has vomited dark brown material. Associated belching and water brash. Constipated. No jaundice. Has lost fifty pounds in weight in the last nine months.

*Past Medical History.* Never sick before. No history of venereal diseases.

*Social History.* Smokes and uses beer moderately. Has always been a hard-working man, with regular habits.

*Family History.* Wife and four children living and well. No family history of cancer.

*Physical Examination.* Undernourished adult male, with no evident pain or distress. Eyes, ears, and nose negative. Tongue rather beefy red. Teeth in poor condition with pyorrhea. Neck: a few palpable cervical lymph glands. Skin slightly anemic and cachectic, with considerable emaciation.

Lungs: Small, moist rales at the posterior left apex and a few rales over the right lung posteriorly. Slight impairment of resonance at the left apex.

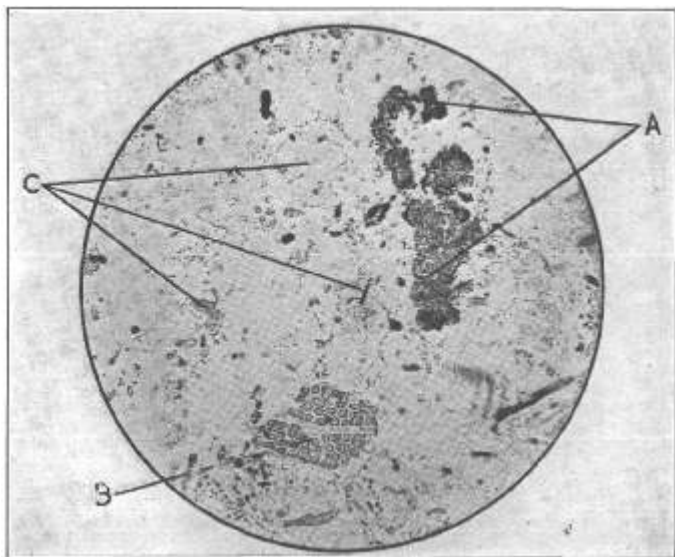


FIG. 1.—Nest of cancer cells from Case I, H. F., aged sixty-two years. Free HCl, 0; total acidity, 8. Occult blood positive. Lactic acid negative. Oppler-Boas bacilli not found. Wolff-Junghans reaction positive in  $\frac{1}{100}$  dilution. A, nest of cancer cells; B, bundles of striated muscle fibers from retained food residue; C, necrotic debris with streptococci invasion.  $\times 100$ .

Heart: Normal in size and position. Sounds are free from murmurs and accentuations, but first sound at the apex is of poor muscular quality and can scarcely be heard. Peripheral blood-vessels sclerotic.

Blood-pressure: Systolic, 160; diastolic, 78.

Abdomen: Walls thin; tenderness in epigastrium, especially just left of the midline. A sense of resistance can be felt in this area—almost like a movable mass. Abdomen otherwise negative.

Extremities and genitalia negative.

Gastric Analysis: Sixty minutes after Ewald breakfast. Quantity, 90 c.c. Brownish yellow, putrid odor, faintly alkaline. Bile negative. Occult blood positive to benzidine and slightly

positive to guaiac. Free HCl absent; total acidity, 8; lactic acid absent.

Microscopically: A few starch granules partially digested; granular debris. Oppler-Boas bacilli absent. Wolff-Junghans reaction positive in dilution 1 to 320.

*Gastric Sediment:* Shows nest of cancer cells. Necrotic debris, and food rests on six hour fasting stomach (see Fig. 1).

Stool: Grayish-green; semisolid; moderate amount; characteristic odor; alkaline reaction. Bile positive. Occult blood positive to benzidine and to guaiac.

Microscopically: Bile-stained vegetable cells; fatty acid crystals and crystals of triple phosphate; granular debris and bacteria.

Blood Count: Hemoglobin, 58 per cent.; red-blood cells, 3,890,000; color index: 0.76; white blood-cells, 11,400.

Differential Count: Polymorphonuclear neutrophiles, 76 per cent.; lymphocytes, 24 per cent.; large mononuclears, 0; transitionals, 0; eosinophiles, 0; total, 100 per cent.

Fluoroscopic Examination: Stomach not markedly ptotic or dilated. No absolute mass, but there is some slight increase in density toward the cardiac end of the greater curvature.

*Operation* January 9, 1913 (Dr. Deaver). Upper right rectus incision. Stomach exposed. A hard mass was found on the entire lesser curvature extending to the greater curvature and involving the great omentum. Type is scirrhus. Radical cure not possible. Usual closure of wound. Dry dressing.

CASE II (Carcinoma of the Stomach).—J. G., aged sixty-four years; married; occupation, cement finisher.

*Chief Complaint.* Constant pain in epigastrium; loss of weight; anorexia; constipation.

*Present Illness.* Two months prior to admission he developed distress in the gastric area, occurring immediately after meals, with a sense of weight in the epigastrium. "The food seems to lie in my stomach and does not pass out." He has had to lie down on account of weakness after each meal, has difficulty in breathing, and has a constant gnawing pain in the epigastrium, without reference to eating. The pain does not keep him awake at night. His appetite has dwindled so that he can eat very little, and he relishes only liquids and oatmeal. He can not digest any meat and is violently constipated, using drastic cathartics every day. He has never vomited; he has never noticed any blood in his stools, but they have lately been of a dark, blackish-brown color. He, himself, found a lump in his epigastrium about six weeks ago that he thinks is growing larger. He has lost twenty pounds in five weeks.

*Family History.* Wife and three children living; one died in infancy: one of appendicitis and one of epilepsy. No history of cancer, tuberculosis, or hemophilia.

*Past Medical History.* Unimportant.

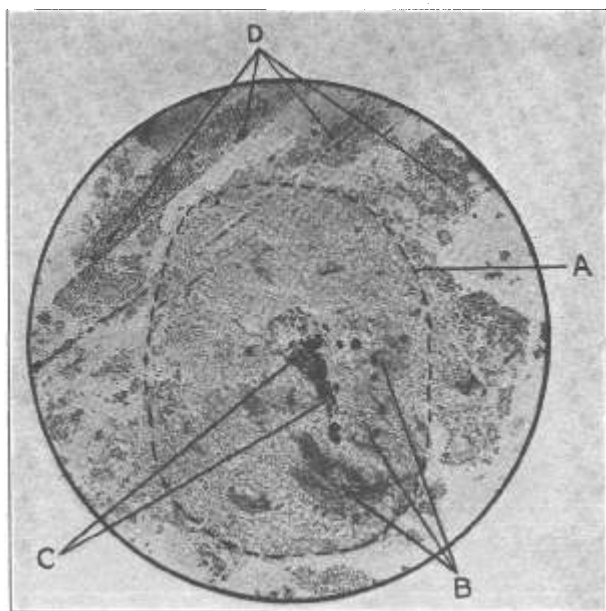


FIG. 2.—Gastric sediment from Case II, J. G., aged sixty-four years, showing necrotic debris and masses of Oppler-Boas bacilli and large numbers of leukocytes. A, necrotic debris; B, masses of Oppler-Boas bacilli; C, necrotic carcinomatous debris; D, collections of leukocytes.  $\times 100$ .

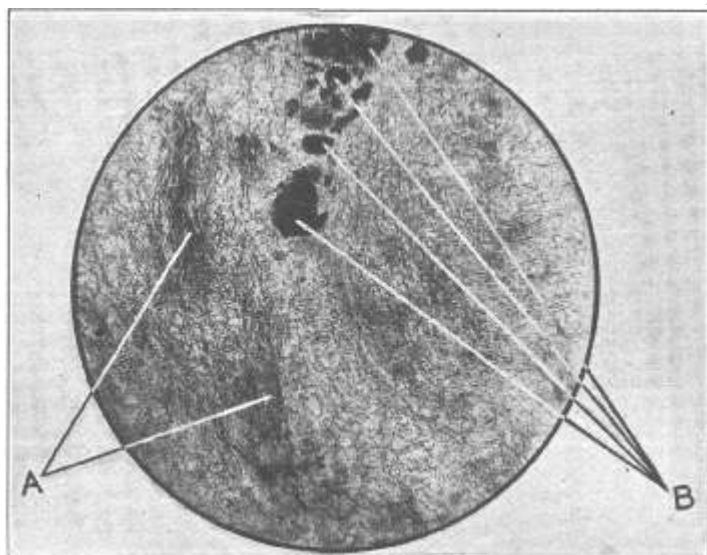


FIG. 3.—Oil immersion of Fig. 2, showing masses of Oppler-Boas bacilli. A, masses of Oppler-Boas bacilli; B, necrotic carcinomatous debris.  $\times 800$ .

*Social History.* Denies venereal disease; smokes moderately; does not use alcohol.

*Physical Examination.* Emaciated adult male in no great pain. Eyes and nose negative. Ears: left, negative; right, quite deaf. Mouth: mucous membranes pale. Teeth: decayed and missing. Tongue: clean and furrowed.

Chest: Heart and lungs surgically negative.

Abdomen: Muscular, difficult to palpate; peristalsis poor; some distention; no rigidity. Mass present, beginning 5 cm. below the xiphoid, extending 4 cm. to the right of the midline and 2.5 cm. to the left of the midline; is hard, resistant, moves slightly downward on deep inspiration, and seemingly involves greater curvature throughout; pain not present on deep palpation. Otherwise abdominal examination is negative except for left inguinal hernia. Genitalia and extremities negative. Blood-pressure: systolic, 140; diastolic, 70.

Blood Count: Hemaglobin, 72; red-blood cells, 4,740,000; color index, 0.76; white-blood cells, 7155.

Differential Count: Polymorphonuclear neutrophils, 53 per cent.; lymphocytes, 23 per cent.; large mononuclears, 16 per cent.; transitional, 5 per cent.; eosinophiles, 3 per cent.; total, 100 per cent.

Stool: Yellowish brown; normal consistency; moderate amount; characteristic odor. Alkaline reaction. Bile strongly positive. Occult blood faintly positive to benzidine and negative to guaiac.

Microscopically: Bile-stained vegetable cells, mucus, and debris. Free fat globules and bacteria.

Urinalyses: Unimportant.

Fluoroscopic Examination. Lower border of the stomach reaches to the umbilicus. Shadow of a dense mass apparently involving the greater curvature.

*Gastric Sediment Study:* Shows a large amount of necrotic debris with degenerated epithelial cells with enormous collections of Oppler-Boas bacilli, particularly surrounding the necrotic epithelial debris, and very large numbers of leukocytes, chiefly polynuclear, with protoplasm intact (see Figs. 2 and 3).

*Operation* December 4, 1912 (Dr. Deaver). Upper right rectus incision. Large mass found involving the anterior wall of the stomach and extending up to the cardia. Carcinomatous invasion of the mesentery and pancreas. Case inoperable. Wound closed.

CASE III (Carcinoma of the Stomach).—S. H., aged fifty-nine years; married; occupation, scale maker.

*Chief Complaint.* Vomiting and pain after eating and belching.

*Present Illness.* Six months ago had an attack of severe hicoughing, with chills, lasting five days and associated with vomiting. He has never felt well since that time. Appetite lessened, and for the last six weeks has had attacks of vomiting, occurring three to

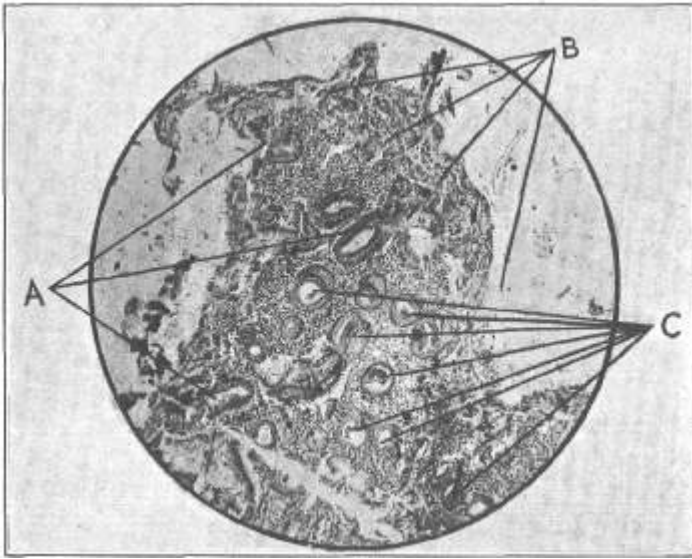


FIG. 4.—Fragment of gastric mucosa showing carcinomatous degeneration. Case III, S. H., aged fifty-nine years. Free HCl, 0; total acidity, 52. Lactic acid positive. Occult blood positive. Oppler-Boas bacilli present. A, rupture of basement membrane and a typical proliferation of epithelium; B, carcinomatous degeneration; C, gastric tubules in various stages of atrophy.  $\times 100$ .

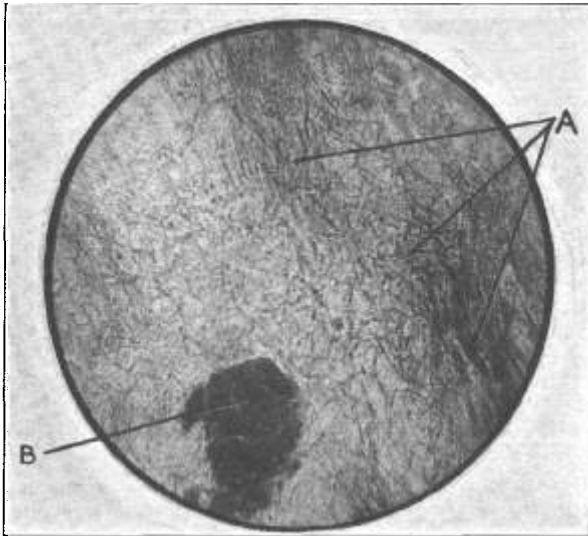


FIG. 5.—Gastric sediment. Case III, S. H., aged fifty-nine years, showing large numbers of Oppler-Boas bacilli. A, Oppler-Boas bacilli; B, necrotic cancer cells.  $\times 800$ .

four hours after eating. No definite retention vomiting, nor has he vomited bloody or blackish material. He does not have much pain before vomiting, but says he feels as though the food was being rolled up into a ball and vomiting gives relief. The pain is not referred to the back, but it is located in the epigastrium and over the gall-bladder. He has noticed that the pain waked him up at night when sleeping on his right side. He has lost twenty pounds in weight in six months. He has much gaseous distention of the stomach and belches a great deal. He has pyrosis but no water brash; has not been jaundiced. Bowels are constipated; no melena. Condition has improved a little during the past two weeks.

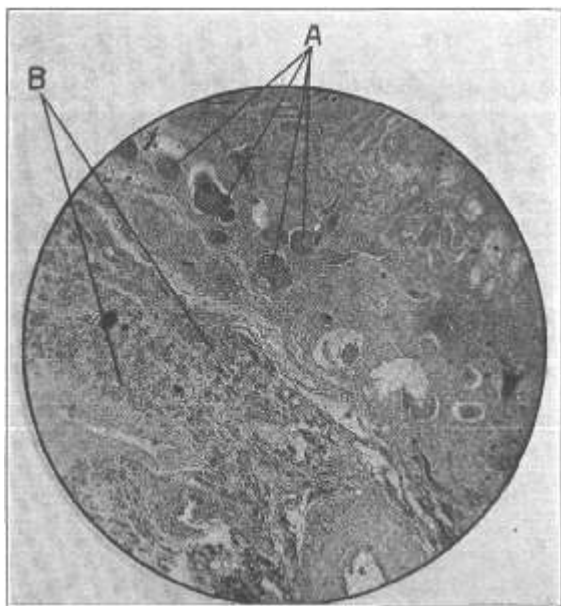


FIG. 6.—Postoperative section (subtotal gastrectomy) from gastric mucosa of Case III, S. H., confirming diagnosis of cancer. *A*, nest of cancer cells in muscularis mucosae; *B*, infiltration of leukocytes.  $\times 100$ .

*Past Medical History.* "Gastric fever" six years ago. Indefinite history difficult to interpret.

*Social History.* Uses alcohol moderately.

*Family History.* Unimportant.

*Physical Examination.* Somewhat emaciated looking; skin pale; eyes, ears, nose, and mouth negative. Lungs surgically negative.

Abdomen: Scaphoidal. Skin: thin and lax muscular walls. No masses detected. Deep palpation elicits diffuse epigastric tenderness, with distinct muscle spasm and tenderness over McBurney's point, but not over the gall-bladder. Otherwise abdomen is negative.



Genitalia and extremities: Negative.

Blood-pressure: Systolic, 112; diastolic, 90.

Blood Count: Hemaglobin, 77; red-blood cells, 4,360,000; color index, 0.89; white blood cells, 8500.

Differential Count: Polymorphonuclear neutrophils, 63 per cent.; lymphocytes, 32 per cent.; large mononuclears, 1 per cent.; transitionals, 4 per cent.; total, 100 per cent.

Gastric Analysis: *Full Meal* (six-hour stomach): 375 c.c. recovered; light brown color; aromatic odor. Bile: negative. Occult blood, 0; free HCl, 0; total acidity, 44; lactic acid, faintly positive.

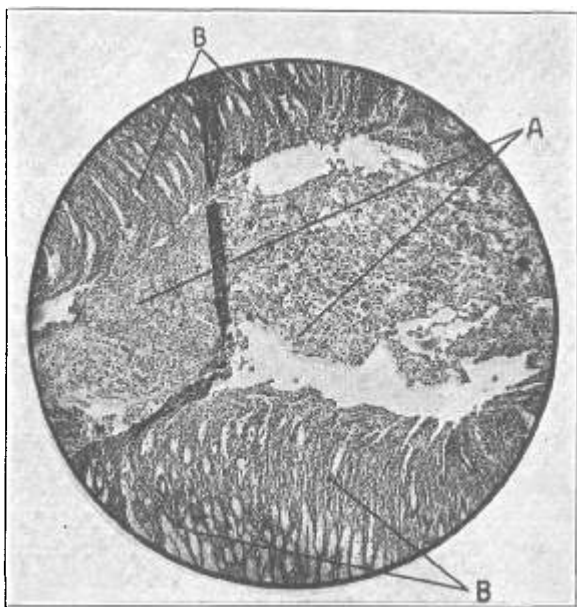


FIG. 7.—Gastric sediment of fragment of gastric mucosa from case of gastritis *acida* and hypersecretion. S. H., aged fifty-nine years, showing A, inflammatory debris containing many polynuclear leukocytes sloughing off between B, two folds of mucous membrane.  $\times 100$ .

Microscopically. Oppler-Boas bacilli present. Granular debris; a few free fat globules and partially digested starch granules and mucus plus.

Ewald breakfast (sixty minutes): 130 c.c. recovered; yellowish-brown, aromatic odor; bile negative. Occult blood: strongly positive to benzidine and negative to guaiac. Free HCl, 0; total acidity, 52; lactic acid, positive.

Microscopically: Oppler-Boas bacilli; fat globules; partially digested starch; granular debris.

Cambridge "C" reaction: Positive.

**Stool Analysis:** Greenish-brown; fluid and small fecal masses; neutral reaction; bile strongly positive; occult blood strongly positive to benzidine. Guaiac negative.

**Microscopically:** Bile stained vegetable cells; few fat globules; debris and bacteria.

**X-ray Reports:** Stomach dilated but not markedly ptosed; lowest border one-half inch below navel; there is an obstruction to the flow of bismuth at the pylorus which shows marked density, presumably from a growth. No other masses detected.

**Gastric Sediments:** Show fragments of gastric mucosa, with areas of carcinomatous degeneration and gastric tubules in various stages of atrophy (see Fig. 4) and other areas showing necrotic cancer debris surrounded by masses of Oppler-Boas bacilli (see Fig. 5).

**Operation** February 1, 1913. Upper right rectus incision. Carcinomatous mass at pylorus and duodenum, involving lesser curvature more than the greater. Head of pancreas hardened. Partial gastrectomy and duodenectomy, removing carcinomatous mass. Posterior gastro-enterostomy. Considerable hemorrhage. Two pieces of gauze to stomach bed for drainage. Usual closure of wound at point of drainage. Patient in bad shape on table and transfused with 3000 c.c. of saline, and immediately after leaving operating room was again transfused with 1500 c.c. of saline; given active stimulation and oxygen, with no avail. Patient died of shock.

**Culture:** From interior of stomach at operation: *Bacillus coli communis*.

**Pathological Report:** Portion of stomach 12 cm. x 9 cm. and 4 cm. thick. Stomach hard and wall thickened. Omental attachment at greater curvature shows two hardened glands, also at lesser curvature. Inner surface of stomach is injected, granular, and shows projecting firm nodules; wall of pylorus is thickened and hard, and cut surface is pale, hard, and resembles gristle.

**Microscopically:** Adenocarcinoma; scirrhus with metastasis to gastric glands (see Fig. 4).

**CASE IV (Cancer of the Stomach).**—H. M., aged forty-five years; occupation, leather worker.

**Chief Complaint.** Pain in the stomach and vomiting.

**Present Illness.** For ten months has been troubled with pain in the stomach and vomiting. Pain is at times sharp and at other times dragging and heavy; is worse at night when he lies down; sometimes relieved by eating and sometimes not; pain is nearly always present to some extent; does not vomit except when pain has been severe; vomiting has been distinctly of the retention type; pain does not radiate; has never been jaundiced; bowels constipated; has lost fifteen pounds.

**Past Medical History.** Usual diseases of childhood; denies venereal history.

*Social History.* Irregular habits; uses alcohol at times to excess. Always more or less constant. Smokes a pipe.

*Family History.* Mother and two brothers died of pneumonia and father of apoplectic stroke.

*Physical Examination.* Fairly well-nourished adult male; hair thin and gray. Tongue clean; no tremor. Eyes, ears, nose, negative. Lungs and heart negative. Abdomen flat; walls lax; visible peristalsis seen at times. Increased resistance over recti muscle in upper abdomen. Area of liver dullness small. No mass detected. Extremities negative August 4, 1913. During the passage of the stomach tube, patient vomited large quantities of food eaten

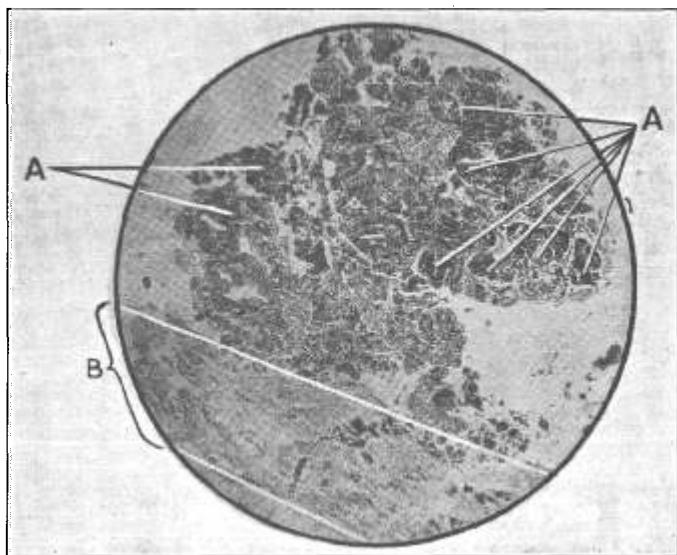


FIG. 8.—Fragment of gastric mucosa from Case IV, H. M., aged forty-five years, showing a carcinomatous degeneration. A, carcinomatous degeneration of gastric tubules; B, submucosa.  $\times 100$ .

eighteen hours ago, probably 1500 c.c., of a sour, fermenting odor like cider. Free HCl, 32; combined, 20; total acidity, 76. Occult blood, negative. No inflation of lower border found at the level of the navel.

August 9. Blood count: hemoglobin, 64 per cent.; white-blood cells, 7200. Stool, brownish-black; semifformed; bile strongly positive; occult blood strongly positive to benzidine; negative to guaiac.

August 20. Wassermann reaction negative.

August 19. Fluoroscopic Examination (with 80 gm. bismuth subcarbonate). Moderate gastrectasis; lowest border of stomach is two and a half inches below the navel; sluggish peristalsis; no mass

detected. Full meal removed in seven hours. 230 c.c. of brownish-yellow, sour-smelling chyme; increased intimately mixed mucus; bile negative. Occult blood positive to benzidine; negative to guaiac. Free HCl, 53; total acidity, 95. Butyric acid positive.

Microscopically: Some undigested starch; free fat globules; epithelial cells; no Oppler-Boas bacilli.

August 22. Ewald breakfast removed in sixty minutes by aspiration bottle and over 500 c.c. of mixed contents recovered. Bread crumbs and water plus prune pulp, coagulated casein, and albumen from milk and eggs from night of August 21. Mucus plus; sour odor. Free HCl, 12; combined HCl, 0; total acidity, 30; occult blood negative in filtrate. Butyric acid positive. Starch digestion to maltose.

Microscopically: Starch granules; meat cells; sarcinae; free fat globules; no Oppler-Boas bacilli.

*Gastric Sediment*, August 22. Fragment of gastric mucosa shows tubules in various stages of atrophic degeneration, with areas of carcinomatous degeneration showing an invasive tendency; high grade leukocytic infiltration; no bacteria demonstrable (see Fig. 8).

Operation advised but declined until two months later (October 6), when patient was referred to the surgical wards with an increase in symptoms and continued loss of weight.

*Operation*, October 8, 1913 (Dr. Deaver). Upper right rectus incision. Stomach was brought up and a mass found involving the pylorus and head of the pancreas. Posterior gastro-enterostomy was done in the usual way. Patient left the table in poor shape but reacted well to a transfusion of 2000 c.c., and was discharged from the hospital October 20.

October 6, 1914. When seen today at the Jefferson Hospital Clinic, one year after his operation, it was learned that for nine months following the gastro-enterostomy the patient had shown marked improvement in symptoms with the cessation of his retention vomiting and a gain in weight from 116 to 160 pounds. About three months ago his appetite began to fail; he began to lose weight; his symptoms of sour stomach and retention vomiting returned. Lavage today shows overnight retention. On physical examination there is a large palpable mass, about the size of a small orange, in the upper right epigastrium, about an inch and a half to the right of the midline. Liver is enlarged, the lower edge being palpable two finger-breadths below the costal margin in the mammillary line; edge rounded; upper border of liver dulness extends to the fourth interspace.

October 22. Ewald breakfast aspirated at sixty minutes; 100 c.c. of reddish-brown bread crumbs and debris, having an aromatic odor with macroscopic blood spots and great increase in intimately mixed mucus. Free HCl, 20; combined HCl, negative; total

acidity, 20. Occult blood strongly positive. Starch digestion to maltose.

Microscopically: Red blood cells; starch granules; no Oppler-Boas or other bacteria.

Wolff-Junghans reaction: Positive in 1 to 80 dilution but negative in higher dilutions.

December 22, 1914. Fractional analysis of Chart I.

Patient referred to medical wards of Jefferson Hospital October 22, where he remained until his death, March 25, 1915, twenty months after the diagnosis by gastric sediment study had been made. During the weeks prior to his death there was a rapid advance in his cachexia, anemia, and the increase in his liver dul-

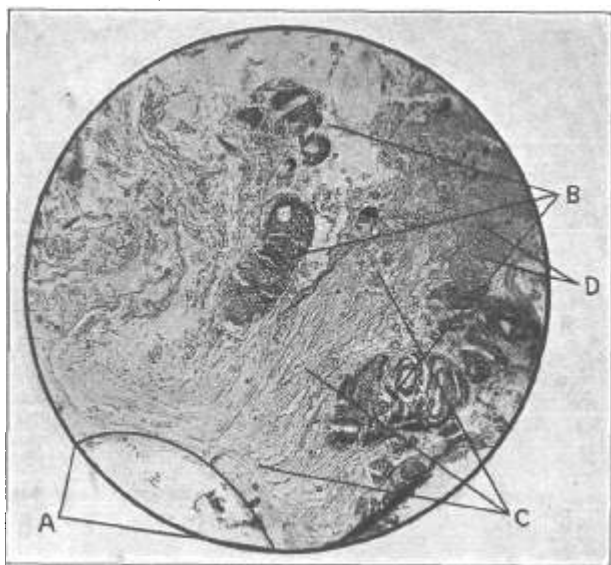


FIG. 9.—Gastric sediment showing fragment of mucosa of the human stomach in a case of advanced, atrophic gastritis. (Achyilia gastrica, Case V, Mrs. A. H.) A, muscularis mucosae at point of rupture; B, gastric tubules in various stages of atrophic degeneration; C, increase in interglandular connective tissue; D, area of congestion.  $\times 100$ .

ness, with the appearance of jaundice, six weeks before he died and subsequently the development of abdominal ascites, due to blockage of his portal circulation.

At autopsy a mass was found involving the pylorus and the greater curvature, the greater omentum and the head of the pancreas, and there were extensive metastases to the mesenteric and retroperitoneal glands and to the parietal peritoneum of the abdominal wall and the under surface of the diaphragm. The liver was enormously enlarged, particularly upward. The upper border was found pushing up the diaphragm to the second interspace, and the right lung was collapsed and undergoing pressure atrophy. The

liver was everywhere studded with carcinomatous nodules, in various stages of necrosis. The gall-bladder likewise showed metastases. There were about eight quarts of straw-colored fluid in the abdominal cavity. The gastro-enterostomy opening was markedly narrowed, due to the advanced carcinomatous process along the greater curvature. The stomach was enormously dilated, and when cut open was found to contain about a pint of dark chocolate-brown granular debris, foul smelling, from which further sections were prepared which show desquamated epithelium extensively invaded by cancer.

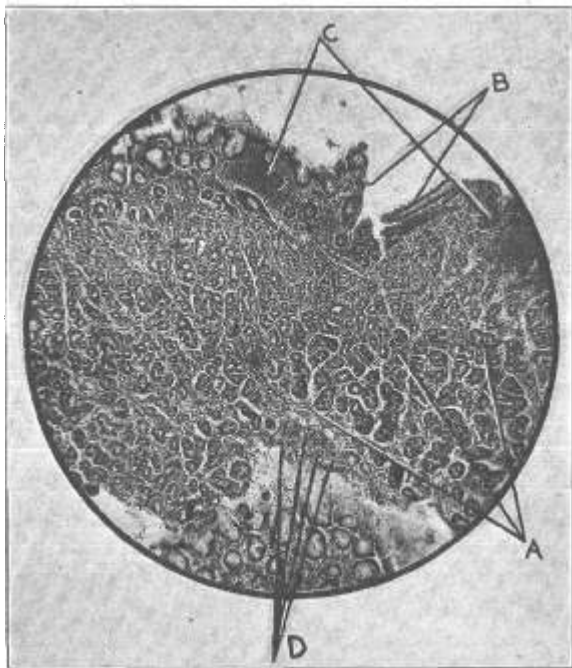


FIG. 10.—Fragment of mucosa from a case of gastric ulcer with free HCl, 86; combined HCl, 21; total acidity, 110. Occult blood positive. A, glandular hyperplasia; B area of superficial erosions; C, area of congestion (occult blood positive); D, areas of leukocytic infiltration.  $\times 100$ .

**CASE V (Achyilia Gastrica).—**Mrs. A. H., aged thirty-one years; occupation, housework.

*Complaint.* Stomach trouble for fifteen years off and on; gradually getting worse; until now is unable to eat without distress. Worse symptom is excessive bloating relieved by belching; a sense of smothering with cardiac palpitation. At night must sleep on left side. Epigastric sense of pressure and discomfort; very little nausea; no heart burn; regurgitation of bland fluid; no pain; has lost eleven pounds in the last year and now weighs eighty pounds.

No cough; no sputum; no night sweats; very nervous; has headaches; is easily fatigued and has attacks of dizziness; regular in habits of eating. Bowels are constipated, scybalous, with intermittent diarrhea.

*Past Medical History.* Unimportant, except for tendency to anemia (simple).

*Physical Examination.* Fairly well nourished and developed little woman, perhaps five feet tall. Hair, eyes, ears, nose, mouth negative. Color good. Visible mucous membranes very slightly pale. Complete absence of nails on both thumbs and both index fingers, which she states is congenital, and has appeared in each generation for several generations. Chest well formed; symmetrical. Lungs negative, except for moderate dullness at both posterior apices. Heart negative. Abdomen: liver dullness normal in extent; spleen and kidneys not palpable. Stomach

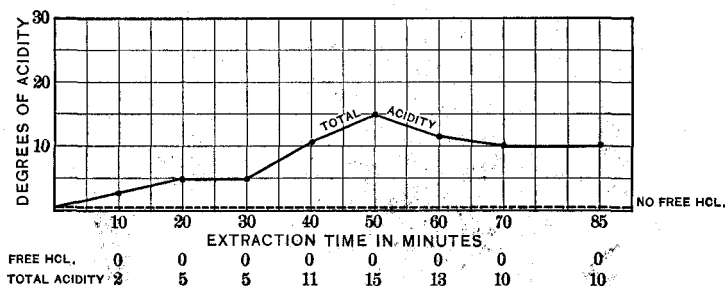


CHART I.—H. M., Case IV. December 22, 1914. Cancer of stomach. Total chemical achylia; malignant. Wolff-Junghans reaction positive. Occult blood, ++.

normal in position, somewhat dilated, particularly to the left. Knee-jerks exaggerated.

**Blood Count:** Red-blood cells, 5,104,000; hemoglobin, 88 per cent.; color index, 0.8; white-blood cells, 6,000. Differential count: Polymorphonuclear neutrophils, 60 per cent.; transitionals, 34 per cent.; lymphocytes, 32 per cent.; large mononuclears, 4 per cent.; total, 100 per cent. No polychromatophilia; no poikilocytosis; no nucleated red cells.

**Urinary Analyses:** All negative except for low specific gravities, from 1,006 to 1,015.

**Examination of stools** shows free-fat globules; fatty acid crystals; a few striated muscle fibers; otherwise negative.

**Gastric Analyses:** A series of gastric analyses (twelve in number) covering a period from July 26, 1912, to August 11, 1915, have all shown a total achylia. No free HCl occurred at any time; a combined HCl on two occasions of 2 and on one occasion 10.4, and total acidities ranging from 6 to 12 after Ewald test meals and on one occasion 15 after a mixed meal. There have never been present either enzymes or proenzymes. There has uniformly been found a considerable amount of intimately mixed mucus. Occult blood

reactions in the gastric filtrates have been negative except on one occasion. Starch digestion has been uniformly active, always passing through the erythro- and acroödextrin stages and giving well-marked sugar reactions. The odor has always been bland like that of bread soaked in water. The rate of motility has always been increased. The amounts recovered at sixty minutes from Ewald test meals of 35 gm. of bread and 300 c.c. of water, varying between 15 and 35 c.c. in amount and giving about 50 per cent. of filtrate. Fractional studies, withdrawing small amounts at intervals of ten minutes, have likewise shown a total achylia during the entire digestive cycle (see curve, Chart II).

*Gastric Sediments:* From time to time flakes of mucous membrane have been recovered, usually showing point of rupture at muscularis mucosæ; marked diminution in glandular elements with gastric tubules showing various stages of atrophic degeneration and a considerable increase in the interglandular connective tissue,

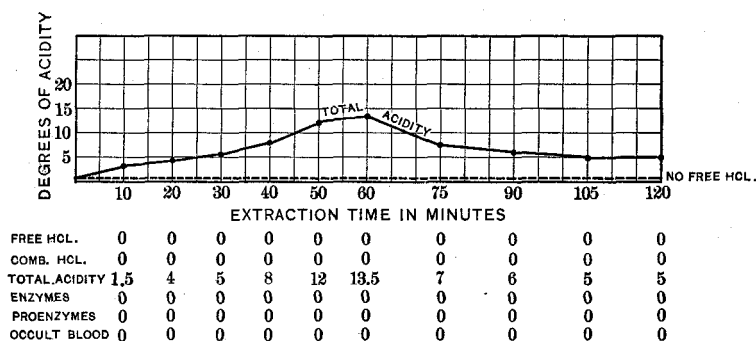


CHART II.—MRS. A. H., Case V. January 12, 1915. Achylia gastrica. Total chemical achylia; benign.

with occasional areas of congestion, and at the periphery often showing a layer of mucus (see Fig. 9). The Wolff-Junghans reactions have been negative, showing a demonstrable albumin ring in no dilution above 1 to 20. Under a substitution form of therapy, using fairly large amounts (30 to 60 drops) of dilute hydrochloric acid and essence of pepsin with meals and 5 to 7 grains of pancreatin three hours after meals, the progress of this case has been most satisfactory. She has been encouraged to take a morning cold bath and moderate exercise in the open air, and as much amusement as she wishes. Her diet has been arranged to give the maximum amounts of protein, carbohydrates, and fats to the point of digestive tolerance, and without showing any of these elements in her stool. For practically two years and at present she has been symptomatically cured, notwithstanding the persistent failure in gastric juice. Her weight has been increased, and now fluctuates between sixteen and twenty pounds more than when she first came under observation.